

Defense Science Board
Task Force

on

**The Roles and Authorities of
the Director of Defense
Research and Engineering**



October 2005

Office of the Under Secretary of Defense
for Acquisition, Technology and Logistics
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DEFENSE SCIENCE
BOARD

28 Oct 2005

MEMORANDUM TO THE UNDER SECRETARY OF DEFENSE FOR
ACQUISITION, TECHNOLOGY AND LOGISTICS

SUBJECT: Report of the Defense Science Board Task Force on the Roles and
Authorities of the Director of Defense Research and Engineering
(DDR&E)

I am forwarding to you the report of the Defense Science Board Task Force on
The Roles and Authorities of the Director of DDR&E. This report underscores the
important contributions of technology in meeting the objectives of the nation's
military strategy and calls for science and technology considerations to again play
a more central role in influencing defense strategy, policy, programs, and
resources.

The task force does not argue for new organizations or new authorities.
However it does call for active participation of the Secretary of Defense and
Deputy Secretary of Defense, along with AT&L leadership, to champion a robust
science and technology effort in DOD.

I agree with the findings and recommendations of this report and commend
them to your attention.

William Schneider, Jr.
DSB Chairman



OFFICE OF THE SECRETARY OF DEFENSE

**3140 DEFENSE PENTAGON
WASHINGTON, DC 20301-3140**

**DEFENSE SCIENCE
BOARD**

MEMORANDUM TO THE CHAIRMAN OF THE DEFENSE SCIENCE BOARD

SUBJECT: Report of the Defense Science Board Task Force on the Roles and Authorities of the Director of Defense Research and Engineering

Our task force was charged to evaluate the roles and authorities of the Director of Defense Research and Engineering (DDR&E). We did so in the context of technology's contributions to meeting the nation's security and defense objectives.

An unsurpassed ability to understand and exploit the military implications of technology has long been a cornerstone of U.S. defense strategy. It is no less important today that DOD's strategies, plans, and programs be so informed by science and technology in order to meet a quite different security environment.

However, we believe that the attributes that have served the nation so well—technical leadership at high levels in DOD, a world-class technical staff in the OSD, and technology investments informed by long-term visions—are eroding. Thus, DOD is not as well positioned as it should be to meet the challenges and exploit the opportunities offered by technology.

The globalization of technology provides adaptive adversaries means to inflict serious damage to U.S. interests. DOD's early access to these technologies is hampered by Cold War-era research, development, and acquisition processes. The capabilities that are needed to deal with the new threats require exceptionally close coupling of technology to new concepts, doctrine, tactics, and training. Furthermore, rapidly evolving technologies—such as bio- and nanotechnologies—will have military implications beyond today's understanding.

We recommend neither new organizations nor new authorities to address these challenges. Sufficient authority already exists.

The primary role for DDR&E as DOD's chief technology officer (CTO) should be focusing on strategic issues while providing oversight of the S&T portfolio as a lesser priority. However, sole responsibility cannot be delegated to the DDR&E. It will take the Secretary of Defense sharing our concerns and the strong leadership of the Under Secretary of Defense for Acquisition, Technology, and Logistics (USD [AT&L]). Strategic technology issues, including championing a robust science and technology (S&T) effort, should be a responsibility second to none in the USD (AT&L)'s portfolio.

A strategic technology plan, taken seriously by the most senior leadership in DOD, can be a valuable tool and we recommend that the Secretary of Defense direct the USD (AT&L) to develop such a plan. The plan should identify the handful of technology enablers of future critical capabilities and missions. As an example of such a plan, we point to the identification and pursuit of stealth, precision, and tactical intelligence, surveillance, and reconnaissance, by DOD leadership in the late 1970s which enabled the powerful capabilities demonstrated in Iraq in 1991. The plan should also address how the DOD can more successfully:

- Exploit technology developed outside of DOD
- Anticipate adversaries' exploitation of technology
- Apply technology to reduce system costs
- Insert new capabilities rapidly into ongoing operations
- Sustain a robust long-term research effort
- Supply S&T and systems engineering talent that DOD needs

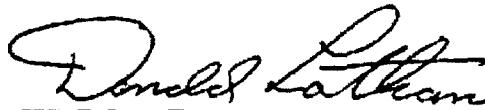
A serious concern we have about the USD (AT&L) and DDR&E being able to fulfill their responsibilities stems, not from a lack of authority, but from the thinness of their technical staff. The staff is capable and hardworking, but does not come close to matching the breadth and depth of technical talent and experience inside OSD during much of the Cold War. Today's challenges merit the same capability. DARPA provides an existence proof that it is still possible to recruit first class technologists into DOD.

Therefore, we recommend that the Secretary of Defense foster an initiative to improve the technical competence and industrial management experience of the staff in OUSD (AT&L). In the report we suggest several mechanisms that could be exploited, but there is nothing more important than providing an empowering work environment.

The chairmen speak for all members of the task force in expressing our appreciation for the efforts and critical contributions of Beth Foster (Executive Secretary), LTC Scott Dolgoff and CDR Cliff Phillips (DSB representatives) and Barbara Bicksler, Julie Evans and Grace Johnson (staff).



Dr. Theodore Gold
Task Force Co-Chair



Mr. Donald Latham
Task Force Co-Chair

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EXECUTIVE SUMMARY

This Task Force was charged with examining future roles and authorities of the Director of Defense Research and Engineering (DDR&E). We considered these roles and authorities in the context of how technology contributes to meeting national security and defense objectives.

An unsurpassed ability to understand and exploit the military implications of technology has long been a cornerstone of U.S. defense strategy. The success of the Department of Defense (DOD) in these areas has been enabled by technical leadership at high levels in the Department, world-class technical staff, and technology investments informed by long-term visions. However, we are concerned that DOD is not well-positioned today to meet new challenges and exploit new opportunities offered by technology. These opportunities and challenges include the following:

- The implementation of critically important new operational capabilities, e.g., finding and tracking terrorists and insurgents; assuring command, control, and communications networks; providing protection to personnel and vehicles; detecting and disabling nuclear, chemical, and biological weapons.
- The commercialization and globalization of technology makes it increasingly available for potential adversaries to use against our interests. On the other hand, DOD's early access to these technologies is made more difficult as commercial technology moves offshore and is further hampered by Cold War-era research, development, and acquisition processes and practices. We are seeing adversaries able to turn technology into capability quicker than DOD's acquisition processes allow.

- Rapidly evolving technologies—such as bio- and nanotechnologies—will have profound military implications beyond our understanding today.
- Increasing pressures to cut long-term and potentially disruptive science and technology investments due to short-term demands and top-line budget constraints.

We recommend neither new organizations nor new authorities to address these challenges. We further believe that sole responsibility cannot be delegated to the DDR&E. Instead, it will take the Secretary of Defense sharing our concerns, the active participation of the Secretary and Deputy Secretary of Defense in crafting a strategic technology plan, and the strong leadership of the Under Secretary of Defense for Acquisition, Technology, and Logistics (USD [AT&L]). Strategic technology issues, including championing a robust science and technology (S&T) effort, must be a responsibility second to none in the USD (AT&L)'s portfolio.

Specifically we recommend that the Secretary of Defense¹ perform the following:

- **Direct the USD (AT&L) to develop S&T objectives, agreed upon by the Secretary of Defense, an S&T strategy, and a strategic technology plan. A list of technologies, even prioritized, does not constitute a strategic plan. The plan should identify the handful of technologies critical to enable those capabilities that in turn are critical to support U.S. national security objectives and strategies.**

Such a plan was designed in the late 1970s, by then Secretary of Defense Harold Brown and Under Secretary of Defense for Research and Engineering William Perry to support their “offset strategy.” The identification and pursuit of stealth, precision, and tactical intelligence, surveillance, and reconnaissance, brought realization of the powerful

1. A draft implementation memorandum is included in Appendix J.

new capabilities demonstrated in Iraq in 1991. These capabilities depended not only on the technological advances, but also on the complementary air-land battle conceptualization by the Services.

The strategic technology plan should also describe how DOD can more successfully accomplish the following:

- Exploit technology developed outside of DOD in the commercial sector, academia, and other government agencies.
- Anticipate and prepare for adversaries' exploitation of technology, both readily available and advanced.
- Apply technology to reduce the total cost of acquiring and maintaining capabilities.
- Provide for more rapid insertion of new capabilities into ongoing operations. Closer collaboration between technologists and warriors is a necessary step.
- Ensure an adequate level of long-term research for DOD needs.
- Supply the S&T and systems engineering talent that DOD needs.

These objectives, or an equivalent list approved by the Secretary of Defense, are the strategic technology challenges that must shape the DDR&E's agenda.

- **Foster – via direction, interaction with Congress, and follow-up – an initiative to improve the technical competence and industrial management experience of the leadership and staff in the office of the USD (AT&L), including DDR&E and Defense Systems.**

This initiative can be accomplished by making more aggressive use of existing mechanisms, including the

EXECUTIVE SUMMARY

Experimental Personnel Hiring Authority under
Section 1101 of the 1999 National Defense
Authorization Act, the Intergovernmental Personnel
Act (IPA), and one-year rotational assignments for
career civil servants.

INTRODUCTION

The National Defense Authorization Act for Fiscal Year 2005 directed that the “Secretary of Defense shall carry out a study of the roles and authorities of the Director of Defense Research and Engineering” and that the study should be conducted by the Defense Science Board (DSB).² In execution of this request, the Under Secretary of Defense for Acquisition, Technology, and Logistics (USD [AT&L]) convened a Defense Science Board Task Force to undertake this study.

In particular, the Task Force was directed to include the following in its review:³

- An examination of the past and current roles and authorities for the Director of Defense Research and Engineering (DDR&E)
- Appropriate future roles and authorities for the director, including an analysis of
 - The relationship of the director to senior science and technology and acquisition officials of the military departments and defense agencies
 - The relationship of the director to a range of functions, including planning and programming for research and engineering programs, managing the laboratories, promoting rapid technology transition and technology transfer, coordinating research and engineering activities with those outside of the

2. Ronald W. Reagan National Defense Authorization Act for Fiscal Year 2005, H.R. 4200, Section 901.
3. Appendix A contains the complete Task Force terms of reference, which is a direct version of the congressional language. Appendices B and C, respectively, list the Task Force membership and the presentations received by the members.

Department of Defense (DOD), technical review of acquisition programs, training and education of the technical workforce, maintaining the national technology and industrial base, and development of new technologies

- An examination of the duties of the DDR&E as chief technology officer of the Department of Defense

The Task Force considered these roles and authorities in the context of how technology contributes to meeting national security and defense objectives. The effectiveness of the U.S. Armed Forces on the battlefield and their superior advantage compared to militaries worldwide derive, in large measure, from the development and integration of advanced technology and, in particular, from maintaining leadership in technology development.

THE ROLE OF TECHNOLOGY IN DOD STRATEGY, PLANNING, AND PROGRAMMING

In his report *Science: The Endless Frontier*, Vannevar Bush, President Roosevelt's architect for World War II research, said, "In this war, it has become clear beyond all doubt that scientific research is absolutely essential to national security." Throughout the Cold War, DOD strategies, plans, and programs were informed by a deep understanding of the implications of technology. A defining event, the launch of Sputnik in October 1957, spurred the creation of processes, positions, and organizations to assure that science and technology (S&T) played a major role in shaping DOD's strategic planning, resource allocation, and overall implementation during the Cold War.

From the Defense Department's creation in 1947, its approaches to managing, supporting, and harnessing S&T for military needs have evolved in response to changes in perceived threats, economic and technical challenges to the United States, and the priorities of different administrations and DOD leaders.⁴

Since the mid-1980s, the Department's management approach has been dispersed and decentralized. The Office of the Secretary of Defense (OSD) has provided a role best described as policy and oversight. This contrasts with the more proactive, high-level, direction- and strategy-shaping roles characteristic of the 1960s and 1970s—the period following the establishment of the DDR&E in 1958.⁵ For example, in the 1970s, OSD drove several decisive technological developments—stealth, stand-off precision strike, and tactical intelligence, surveillance and reconnaissance systems—that have transformed U.S. military capabilities, as was demonstrated in Operations Desert Storm and Iraqi Freedom.

4. Appendix D provides a history of how science and technology has been managed through the Office of the Director of Defense Research and Engineering. Appendix E contains an overview of the management priorities of the DDR&E office today.
5. In Appendix F, Dr. John Foster offers reflections on the role of the DDR&E during his tenure from 1965 to 1973.

It is no less important today that DOD's strategies, plans, and programs be so informed by S&T in order to meet the quite different situation and new challenges. A profound difference between today and the Cold War is the commercialization and globalization of technology (see appendix G). No longer does the United States government (through DOD, the Department of Energy, the intelligence community, and other agencies) and its laboratories and contractors own or control most of the defense-relevant technology.

The commercialization and globalization of technology makes it increasingly available for potential adversaries to use against U.S. interests. DOD's early access to these technologies is made more difficult as commercial technology moves offshore and is further hampered by Cold War-era research, development, and acquisition processes and practices. We are seeing adversaries able to turn technology into capability quicker than DOD's acquisition processes allow. Rapidly evolving technologies—such as bio- and nanotechnologies—will have profound military implications beyond our understanding today.

The most immediate threat today—non-state actors able to inflict strategic harm—is different from the Cold War threat, with even greater potential for the disruptive use of technologies. Critical U.S. military capabilities dependent on new technology include the following:

- Finding, identifying, tagging, and tracking terrorists and insurgents.
- Detecting nuclear, biological, and chemical devices.
- Assuring command, control, and communications networks and the information they convey in the face of threats to disrupt, corrupt, and deceive. The threats range from electromagnetic pulse to computer hacking. The networks include transmissions related to the Global Positioning System as well as more traditional communications.

- Exploiting unmanned systems – air, sea, and ground – to the fullest. Necessary enablers of these capabilities are technologies that provide “system awareness and perception.” These capabilities will change how we fight and train.
- Conducting distributed adaptive operations. One enabler is greater energy efficiencies achieved through battery density, engine design, lightweight structures (including exploitation of nanotechnology), and aerodynamics.
- Fielding a more rapid and precise strike capability, e.g., via low-cost, directed energy weapons for both neutralization and destruction.
- Protecting forces on the ground. The span of relevant technologies is extensive with applications to personnel and vehicle protective armor; detection and disablement of improvised explosive devices; persistent surveillance and reconnaissance; and rapid analysis, synthesis (including pattern recognition) and sharing of information.

Indeed, technology is a necessary enabler of transformational advances in DOD’s key operational capabilities as spelled out in the National Defense Strategy: strengthen intelligence, protect critical bases of operation, operate from the global commons, project and sustain forces in distant anti-access environments, deny enemy sanctuary, conduct network centric operations, and deal with irregular challenges. Technology also has an important role to play in another key operational capability: increasing capabilities of partners, both international and domestic.

We have great concern that today’s strategy, plans, programs, and resources are not being adequately informed by considerations of S&T, and are not meeting the challenges of the new security environment. Furthermore, there are underlying trends that may make it more difficult to do so in the future. These include a smaller talent pool of individuals, than available during the Cold War, with the requisite technical knowledge willing to work in DOD. National

security is no longer the magnet for the nation's technical talent that it was during much of the Cold War, particularly after the shock of the Sputnik launch by the Soviet Union in October 1957. DOD faces stiffer competition from the commercial world for the Services of talented technologists. Therefore it is becoming less likely that technologists will be a part of the senior decision-making circle.

Over time there has been a relative decline in the influence in strategic matters of the DDR&E, and more importantly, the Under Secretary of Defense for Acquisition, Technology, and Logistics. In addition, funding for long-term research, as reflected in the DOD fiscal year 2006 budget submittal, is still below levels recommended in past DSB studies, which advocated S&T investments at three percent of total obligation authority.⁶

The DDR&E is the Department's point person to assure S&T has a defining role in the transformation of military capabilities and avoidance of technological surprise. While we focus on the DDR&E in this report, we cannot overstate the critical role that the USD (AT&L) must take in these areas. In fact, today the closest successor to the Cold War DDR&E is not the current DDR&E position, but the USD (AT&L). The USD (AT&L) cannot merely delegate these responsibilities to the DDR&E, while the Under Secretary focuses on other matters. Instead, strategic technology issues, including championing a robust S&T effort, must be a responsibility second to none in the USD (AT&L)'s portfolio.

6. *Defense Science Board 2001 Summer Study on Defense Science and Technology*, Washington D.C.: Office of the Under Secretary of Defense for Acquisition, Technology and Logistics, May 2002.

WHAT SHOULD BE DONE?

ORGANIZATION, ROLES, AND AUTHORITIES

We do not believe major changes in organization, roles, or authorities are needed, nor would they be beneficial.

We recommend that the DDR&E position remain under the Under Secretary of Defense for Acquisition, Technology, and Logistics. Some have suggested that the DDR&E report directly to the Secretary of Defense, as it was in the early years. However, we believe it is important to keep S&T tightly coupled to acquisition and logistics, rather than to raise the rank of the S&T advocate and organizationally separate it from acquisition and logistics.

The current organization does place great responsibility on the USD (AT&L) to ensure that the implications of S&T – both opportunities for the United States and dangers from adversaries – fully inform decisions on strategy, plans, and programs. It also places a responsibility on the Secretary and Deputy Secretary of Defense to be proactive in getting these inputs. Per Goldwater-Nichols, on acquisition matters, the USD (AT&L) reports directly to the Secretary of Defense (not through the Deputy Secretary), so the level of authority is sufficient.

We do not see the need for additional directives that would give the DDR&E more “control” over the Defense Advanced Research Projects Agency (DARPA). The nature of DARPA’s business – to pursue ideas of high risk and very high payoff – requires some separation from normal bureaucratic processes. The relative influence of the DARPA Director and the DDR&E over such investment decisions should be left to the Secretary and USD (AT&L) and would be dependent on the individuals filling the DARPA and DDR&E positions. The DARPA director clearly does have a responsibility to ensure that the DDR&E is fully informed of DARPA’s plans and programs. This requires recurrent communication between the staffs, in addition to meetings of the two directors.

Moreover, we do not see the need for change to the directives specifying DDR&E's roles and authorities. Current directives are sufficient to enable an effective DDR&E role. DOD Directive 5134.3 (November 3, 2003) calls out 15 responsibilities and functions and provides adequate authorities to carry these out (see appendix H). The issue is which of these responsibilities, covering a wide range of activities, should get priority.

We believe that the primary role for DDR&E as DOD's chief technology officer (CTO) is to focus on strategic issues and provide oversight of the S&T portfolio as a lesser priority. The essence of the CTO's role goes beyond oversight of the Department's research and engineering activities and is captured by item 4.2 in DOD Directive 5134.3.⁷ The CTO role is to "develop the strategies and supporting plans that exploit technology and prototypes to respond to the needs of the Department of Defense and ensure U.S. technological superiority."

Doing this job effectively requires guidance and support from the Secretary of Defense and, as we have already indicated, intense involvement by the USD (AT&L). DDR&E is a staff position to the Secretary of Defense, not a line manager. To a great extent, the influence of the office depends on the relationship among the DDR&E, the USD (AT&L), and the Secretary.

The tension among investment opportunities with near-, mid-, or far-term payoffs is ever present. These tensions lead to the hard calls that routinely challenge the senior leadership of large enterprises. Few, however, face the momentous consequences of such decisions as does the Secretary of Defense, most particularly in times of war. These hard calls are in essence judgment calls, with no formula or algorithms to ease the way.

We have no doubt that it is critically important to U.S. security objectives for the DOD to sustain a robust S&T program, one that includes a substantial speculative and longer-term component. A

7. Appendix I describes the roles and responsibilities of chief technology officers in both industry and government.

well-articulated vision, a technology strategy for objectives endorsed by the Secretary of Defense, and a technology plan supported with adequate resources are all necessary.

The DDR&E must be the champion in OSD for those investments with longer-term payoffs. Thus, it is vital that the DDR&E be able to "compete" with other claimants for scarce resources by having comparable access to senior decision makers. It was so during the Cold War; it should be again. We believe that the USD (AT&L) is the proper position to oversee this competition and inform and seek the guidance of the Secretary of Defense on its outcome.

Consistent with the role as DOD's chief technology officer, the DDR&E should be tasked to assure that all research and development organizations are implementing the strategic technology guidance of the Department. This responsibility includes "strategic oversight" of all technology efforts in areas such as missile defense; nuclear weapons; biological and chemical defenses; command, control and communications; intelligence; and logistics – whether in the technology implementation plans of the individual Services, defense agencies, or other OSD organizations.

Sufficient mechanisms are in place to make this happen if the Secretary and USD (AT&L) want to make it happen. We do not believe that any new budget authority need be granted to the DDR&E. Through the authority of the USD (AT&L) and the Secretary of Defense, the DDR&E has sufficient influence over the S&T budget. This capacity does not imply that the DDR&E directly manages the S&T activities. However, it does require that the DDR&E be sufficiently knowledgeable about them to make credible assessments about the extent to which the entire portfolio of these activities supports the Department's strategic objectives.

STRATEGIC TECHNOLOGY PLAN AND S&T CHALLENGES

A strategic technology plan, created under the leadership of the DDR&E and the USD (AT&L), endorsed and valued by the Secretary of Defense, could become an effective tool to enable these challenging responsibilities. Without such involvement by the

Secretary of Defense, it would likely become just another bureaucratic document of little value. The plan should focus on the crucial strategic technology challenges and provide an executable chain of logic connecting military missions and technology opportunities.

What are these strategic challenges? The Task Force's short list, deserving more high-level attention, includes the following:

- Gathering and nurturing technology from a variety of sources (commercial, defense industry, academic, other government, as well as in-house sources) and speeding its transition into operational capability.
- Developing and exploiting technology to enable new disruptive capabilities. This challenge entails establishing an environment that tolerates and rewards disruptive ideas and supports emerging concepts for joint operations.
- Identifying and countering disruptive capabilities developed by adversaries using readily available or advanced technology.
- Using technology and associated management approaches to reduce the total cost of acquiring and maintaining capabilities.
- Ensuring an adequate level of long-term research for DOD needs.
- Providing the S&T and systems engineering talent the DOD needs.

Such a list, approved by the Secretary of Defense, would focus DDR&E's activities. We briefly elaborate these challenges.

There may be no more formidable and important challenge for the DDR&E than fostering more exploitation of technology from outside DOD and then shaping a complementary internal S&T program. To be a smart buyer and user of advanced technology, DOD's technical staff must be informed of worldwide science and technology trends, and be aware of current and future science and

technology innovations. This requires lively mechanisms of contact between the scientific and DOD communities, both military and civilian. We believe this contact is eroding. An OSD staff with considerably broader and deeper technical expertise than exists today will be necessary to restore it. We will have more to say about this subject later in the report.

DDR&E should take the lead role in inventing robust processes for rapid technology insertions that can serve the Department well over the coming decades. Fundamental technology development is usually a multi-year effort that provides the opportunity for a quick "last step" from lab to application – whether in the commercial marketplace or to the war fighter on the front lines. For DOD, speeding the application of technology is important not only to provide timely solutions in wartime, but also because the utility of much commercial technology is perishable and needs to be exploited quickly. It appears that at present, speeding technology insertion is treated as a transient need – a special case driven by today's contingencies to speed technology to the battlefield – that will diminish once these contingencies are over. Instead it should be viewed as the norm.

That said, the technology insertion process is complex, requiring participation and accountability from players in the S&T, acquisition, and logistics communities. While we recommend that DDR&E take a leading role in technology insertion, the USD (AT&L) must place high priority on this effort and take a personal role in its implementation. An important element of this implementation would be increased prototyping to demonstrate to the "buyers" that the technology is worthy of transition. This role for DDR&E will increase as DOD implements true spiral development in which an "objective system" is not preordained, but rather the fielding of capability enhancements is influenced by ongoing aggressive technology and experimentation efforts.

With DDR&E's new role in the first stage of acquisition – the budget activity 6.4 accounts in the science and technology budget – there is an opportunity to bring to bear greater influence on how these funds are used to speed rapid transitions to the war fighters. Of

particular significance are the new Joint Concept Technology Demonstration (JCTD) program elements in both the 6.3 and 6.4 accounts, the latter intended to facilitate transition of successful JCTDs to the joint war fighter.

DDR&E has an important role in fostering closer collaboration between operators and technologists. Advanced Concept Technology Demonstration (ACTDs) programs are one mechanism that has had success in fostering such collaboration. ACTDs put prototypes in the hands of operators to develop tactics, techniques and procedures and to demonstrate useful capability. Technologists should also be tied closer into the more speculative war fighting experimentation. In these activities technologists could be providing surrogates (including virtual) rather than prototypes.

A related approach to the ACTDs would be to tie the injection of new technology more closely with training in order to provide a nearer-term technology insertion. This approach would involve testing prototype items in training centers such as the National Training Center, the Joint Readiness Training Center, and the USMC Air Ground Combat Center at Twentynine Palms, California. At the centers, the trainers can develop tactics, techniques, and procedures (on the run) and then let the forces in training try them out in a training context. The prototype items can then be shipped with the force that was trained. This approach is better than drop-shipping items to Iraq.

DDR&E should be tasked to ensure an aggressive effort directed at anticipating and avoiding the effect of potentially disruptive technologies. This effort involves more and more-effective red-teaming and is no easy task. The U.S. Navy's SSBN Security Program is an exemplar of how to do it well. It also involves a significant portion of the S&T activities directed at avoiding surprise – that is, S&T valued for what we learn from it, not only whether it shows up directly in acquisition programs.

A pervasive concern that the Task Force heard was that too much S&T investment was directed at doing better what is already done very well and not nearly enough at identifying disruptive

technologies. Winston Churchill, in *The Great War, Volume 4*, stated this challenge well: "A hiatus exists between the inventor who knows what they could invent ... if they only knew what was wanted ... and the soldiers who knew, or ought to know, what they want and would ask for it ... if they only knew how much science could do for them. You have never really bridged that gap yet." The concern is related to the need to involve technologists much more into the process of developing new concepts for joint operations. Transformational concepts are much more likely to arise when there is intimate collaboration between war fighters and technologists, as happened in the development of the air-land battle concept during the 1970s and early 1980s.

More attention needs to be paid to using technology to reduce the costs of acquiring and sustaining capabilities. While it is accepted that advanced technology can result in greatly improved performance, the historic trend has been to achieve this performance at increasing, and perhaps unaffordable, weapon costs (particularly in the quantities required). However, the commercial world has demonstrated that advanced technology can simultaneously improve performance and reduce costs. Thus, a key element of the strategic role of the DDR&E is to assure that advanced technology is used to reduce weapon systems acquisition and related costs—so that adequate numbers of systems can be affordably acquired for an effective future military force. Moreover, the use of technology to reduce cost should not be limited to materiel, but applied to training, leadership development, and the other critical enablers of military capabilities. Lower cost should be a major consideration in selecting which technologies and systems approaches to pursue.

A sustained and aggressive long-term research program creates opportunities, hedges against surprise, and is vital to the future security of the nation. However, the payoffs from individual projects are uncertain and distant. Bureaucracies have a natural aversion to such speculative investment and we are concerned about recent trends including S&T support in the fiscal year 2006 President's budget. We are not advocating that S&T funding be exempt from budget competition, although that approach was recommended in several presentations to our Task Force. We are saying that a robust

sustained effort in long-term research is unlikely without a strong, credible, and connected (to DOD top leadership) DDR&E champion. S&T is a commitment made to the war fighters of tomorrow, and S&T investment decisions have strategic consequences.

SCIENCE AND TECHNOLOGY WORKFORCE

A serious concern we have about DDR&E being able to fulfill its responsibilities stems, not from a lack of authority, but from the thinness of its staff. They are capable and hardworking. However, we do not intend to denigrate the current staff by pointing out that it does not match the breadth and depth of technical talent and experience inside OSD during much of the Cold War. We believe today's challenges merit the same capability.

The DOD could purchase the technical talent it needs from academia and industry, but DOD must be a smart customer of technology, and the strategic decisions – what to invest in, when to disinvest, assessing the technology readiness of critical programs – require in-house technical talent. In fact, the revolutions in bio and information technology place greater demands for a breadth of technology expertise than existed during the Cold War.

Restoring this quality will be difficult, and we offer no sure-fire solutions. One difficulty in upgrading personnel in OSD is the increasing thinness of the defense industrial base, especially in certain areas, as well as the attractiveness of non-defense, commercial industries for many of the newer, cutting-edge technologies that are in particular demand as DOD changes its focus.

From the 1950s through the 1970s, the “revolving door” between industry and OSD was a major contributor to the DOD’s technical talent pool. Experienced, mid-level, technical managers from the defense industry would come to OSD and DARPA to work for a few years and then return to their firms or other firms in the defense industry. Current ethics legislation has effectively closed this door.

Restrictions on post-DOD employment now inhibit mid-level industrial personnel from joining DOD acquisition organizations. We

appreciate the difficulty of relaxing these restrictions given the current level of Congressional concern regarding ethical behavior in the acquisition community. However, we believe the perceived benefits of these restrictions are outweighed by their cost, impeding the transformation of technology into military capabilities. The long-term costs are significant enough to warrant Secretary of Defense engagement with members of Congress on this matter to identify and implement ways to overcome the potential conflict of interest issues that today impede the flow of experienced talent from the private sector to the government.

Rebalancing the current workforce with the addition of limited appointments and increasing the number of rotational assignments would also enable a more agile and technically competent community within OSD. Mechanisms exist for rotating personnel from industry and academia into government for limited-term appointments. One is the Experimental Personnel Hiring Authority under Section 1101 of the 1999 National Defense Authorization Act. This authority has been used successfully by DARPA to bring technical talent from industry and academia to serve for up to four years.

Other available tools include the Intergovernmental Personnel Act (IPA) and one-year rotational assignments of career civil servants. The IPA provides a means through which individuals from nonprofit organizations and other government agencies can serve as government officials for up to six years. Rotational assignments, used only sporadically within OSD, should be increased not only to bring talent to OSD, but also to allow OSD employees to rotate outside and gain new knowledge and expertise.

CONCLUSIONS AND RECOMMENDATIONS

DOD is not well positioned to meet the challenges and exploit the opportunities offered by advancing technology. This situation presents serious long-term risks to U.S. security. The challenges and opportunities include the following:

- The dependence of critically important new operational capabilities on technology development and integration. Technology will rarely by itself provide the new capability. To be effective, it must be integrated along with changes to doctrine, organization, training, and other complementary enablers.
- The commercialization and globalization of technology increasingly available to potential adversaries for use against our interests while DOD access to this treasure is hampered by Cold War-era R&D and acquisition processes and practices.
Rapidly evolving technologies – such as bio- and nanotechnologies – that will undoubtedly have military implications only dimly understood today.
- Increasing pressure to cut long-term and potentially disruptive science and technology investments due to short-term demands and top-line budget constraints.

We recommend neither new organizations nor new authorities to address these challenges. We further believe that responsibility for addressing these challenges cannot be delegated solely to the DDR&E.

Instead, it will take the Secretary of Defense sharing our concerns, the active participation of the Secretary and the Deputy Secretary of Defense in crafting a strategic technology plan, and the leadership of the USD (AT&L). Strategic technology issues,

including championing a robust S&T effort, must be a responsibility second to none in the USD (AT&L)'s portfolio.

We recommend that the Secretary of Defense⁸

- Direct the USD (AT&L) to develop a strategic technology plan drawing on the experience and knowledge of the DDR&E. A list of technologies, even prioritized, does not constitute a strategic plan. The plan should identify the handful of technologies critical to enabling those mission capabilities, which in turn are critical to supporting the strategies to achieve national security and national defense objectives.

A past example of what we have in mind is the identification of stealth, precision, and tactical intelligence, surveillance, and reconnaissance, in the late 1970s, by then-Secretary of Defense Harold Brown and USDR&E William Perry to support their "offset strategy." It is important to note that the subsequent realization of powerful new capabilities depended not only on the technological advances but also the complementary conceptual work in the Services on air-land battle.

The strategic technology plan should also describe how DOD must become more successful in

- Exploiting technology developed outside of DOD in the commercial sector, academia, and other government agencies.
- Anticipating and countering adversaries' exploitation of technology (readily available and advanced). Doing this will involve the intelligence community and require red teaming and net assessment.⁹

8. A draft implementation memorandum is included in Appendix J.

9. An approach to this type of red teaming and net assessment is discussed in the *Defense Science Board 2005 Summer Study on Transformation:: A Progress Assessment*, forthcoming.

- Applying technology to reduce the total cost of acquiring and maintaining capabilities.
- Providing for more rapid insertion of new capabilities into ongoing operations. Closer collaboration between technologists and warriors is a necessary step.
- Ensuring an adequate level of long-term research for DOD needs.
- Supplying the S&T and systems engineering talent that DOD needs.

These objectives, or an equivalent list approved by the Secretary of Defense, are the strategic technology challenges that must shape the DDR&E's agenda.

- **Foster – via direction, interaction with Congress, and follow-up – an initiative to improve the technical competence and industrial management experience of the staff in the office of the USD (AT&L), including DDR&E and Defense Systems.**
These improvements should be accomplished both by increasing the training and education of the existing staff, for example by rotations through well-managed industries and by recruiting additional experienced, knowledgeable leadership and staff. There should be more aggressive use of existing mechanisms including the Experimental Personnel Hiring Authority under Section 1101 of the 1999 National Defense Authorization Act, the Intergovernmental Personnel Act (IPA) and one-year rotational assignments of career civil servants.

APPENDIX A. TERMS OF REFERENCE

APPENDIX A



THE UNDER SECRETARY OF DEFENSE

3010 DEFENSE PENTAGON
WASHINGTON, DC 20301-3010

DEC 20 2001

ACQUISITION,
TECHNOLOGY
AND LOGISTICS

MEMORANDUM FOR CHAIRMAN, DEFENSE SCIENCE BOARD

SUBJECT: Terms of Reference -- Defense Science Board Task Force on the Roles and Authorities of the Director of Defense Research and Engineering

You are requested to form a Defense Science Board Task Force to study the roles and authorities of the Director of Defense Research and Engineering.

The study shall include the following:

- (1) An examination of the past and current roles and authorities of the Director of Defense Research and Engineering.
- (2) An analysis to determine appropriate future roles and authorities for the Director, including an analysis of the following matters:
 - (A) The relationship of the Director to other senior science and technology and acquisition officials of the military departments and the Defense Agencies.
 - (B) The relationship of the Director to the performance of the following functions:
 - (i) The planning, programming, and budgeting of the research and engineering programs of the Department of Defense, including those of the military departments and the Defense Agencies.
 - (ii) The management of Department of Defense laboratories and technical centers, including the management of the Federal Government scientific and technical workforce for such laboratories and centers.
 - (iii) The promotion of the rapid transition of technologies to acquisition programs within the Department of Defense.
 - (iv) The promotion of the transfer of technologies into and from the commercial sector.
 - (v) The coordination of Department of Defense research and engineering activities with organizations outside the Department of Defense, including other Federal Government agencies, international research organizations, industry, and academia.
 - (vi) The technical review of Department of Defense acquisition programs and policies.



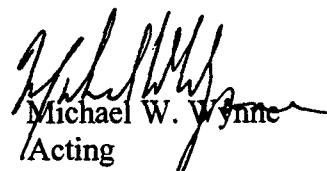
- (vii) The training and educational activities for the national scientific and technical workforce.
- (viii) The development of research and engineering policies and programs relating to the maintenance of the national technology and industrial base.
- (ix) The development of new technologies in support of the transformation of the Armed Forces.

(3) An examination of the duties of the Director as the Chief Technology Officer of the Department of Defense as prescribed by Department of Defense Directive 5134.3, dated November 3, 2003, especially in comparison to the duties of similar positions in the Federal Government and industry.

The report shall include recommendations regarding the appropriate roles and authorities that should be assigned and resources that should be provided to the Director of Defense Research and Engineering.

The Study will be sponsored by me as the Acting Under Secretary of Defense (Acquisition, Technology, and Logistics). Mr. Don Latham will serve as chairman of the Task Force. Ms. Beth Foster, DDR&E will serve as Executive Secretary and Commander David Waugh, USN, will serve as the Defense Science Board Secretariat representative.

The Task Force will operate in accordance with the provisions of P.L. 92-463, the "Federal Advisory Committee Act," and DoD Directive 5105.4, the "DoD Federal Advisory Committee Management Program." It is not anticipated that this Task Force will need to go into any "particular matters" within the meaning of Section 208 of Title 18, U.S. Code, nor will it cause any member to be placed in the position of acting as a procurement official.



Michael W. Wynne
Acting

APPENDIX B. TASK FORCE MEMBERSHIP

CHAIRMEN

NAME	AFFILIATION
Mr. Donald Latham	Private Consultant
Dr. Ted Gold	Private Consultant

TASK FORCE MEMBERS

Dr. Mike Andrews	L-3 Communications
Dr. John Foster	Northrop Grumman Space Technology
Dr. Jacques Gansler	University of Maryland
Mr. Charles Herzfeld	Private Consultant
Dr. Joe Markowitz	Private Consultant
Dr. George Schneiter	Private Consultant
Mr. John Stenbit	Private Consultant
Mr. Dick Urban	Charles Stark Draper Laboratory
Mr. Daniel Winegard	Private Consultant

GOVERNMENT ADVISOR

Dr. Paris Genalis	National Defense University
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EXECUTIVE SECRETARY

Ms. Beth Foster	DDR&E Plans and Programs
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DSB REPRESENTATIVES

LTC Scott Dolgoff, USA	Defense Science Board
CDR Cliff Phillips, USN	Defense Science Board

STAFF

Ms. Barbara Bicksler	Strategic Analysis, Inc.
Ms. Julie Evans	Strategic Analysis, Inc.
Mrs. Grace Johnson	Strategic Analysis, Inc.

APPENDIX C. PRESENTATIONS TO THE TASK FORCE

JANUARY 24, 2005

NAME	TOPIC
Dr. Craig Fields <i>Private Consultant</i>	Developing an Effective Technology Strategy
Mr. Al Shaffer <i>Director, Plans and Programs, Office of the Director, Defense Research and Engineering (DDR&E)</i>	Current Roles and Responsibilities of the DDR&E
Ms. Sue Payton <i>Deputy Under Secretary of Defense, Advanced Systems and Concepts</i>	Mission, Roles, and Functions of the Advanced Systems and Concepts Office in DDR&E
Dr. Charles Holland <i>Deputy Under Secretary of Defense, Science and Technology</i>	DOD Science and Technology
Dr. Bill Berry <i>Acting Deputy Under Secretary of Defense, Laboratories and Basic Sciences</i>	Overview of the Laboratories and Basic Sciences Office
Dr. Tony Tether <i>Director, Defense Advanced Research Projects Agency (DARPA)</i>	DARPA's Organization and Strategic Thrusts

MARCH 2, 2005

Dr. Mike Andrews <i>Chief Technology Officer, L3 Communications</i>	Roles and Responsibilities of Chief Technology Officers
Hon. Ronald Sega <i>Director, Defense Research and Engineering</i>	Roles and Responsibilities of the DDR&E
Hon. Vic Reis <i>Private Consultant (former DDR&E and DARPA Director)</i>	Historical Perspective on DDR&E Roles and Responsibilities

MARCH 14, 2005

ADM J.M. Cohen <i>Chief of Naval Research</i> Mr. James Engle <i>Deputy Assistant Secretary of the Air Force for Science, Technology and Engineering</i> Dr. Thomas Killion <i>Deputy Assistant Secretary of the Army for Research and Technology</i>	Panel Discussion: Relationship Between Service S&T Executives and the DDR&E
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PRESENTATIONS TO THE TASK FORCE

Dr. Glenn F. Lamartin <i>Director, Defense Systems, Office of the Under Secretary of Defense for Acquisition, Technology and Logistics</i>	Systems Engineering
Mr. George Singley <i>Private Consultant (former acting DDR&E)</i>	Perspectives on DDR&E Roles and Responsibilities

APRIL 18, 2005

Hon. Anita Jones <i>University of Virginia (former DDR&E)</i>	Perspectives on DDR&E Roles and Responsibilities
Hon. John S. Foster, Jr. <i>Northrop Grumman Space Technology (former DDR&E)</i>	Historical Perspective on DDR&E Roles and Responsibilities
Dr. Delores Etter <i>U.S. Naval Academy (former acting DDR&E and Deputy Under Secretary of Defense for Science and Technology)</i>	Perspectives on DDR&E Roles and Responsibilities

MAY 17, 2005

Hon. Ryan Henry <i>Principal Under Secretary of Defense for Policy</i>	Importance of Science and Technology in Defense Planning
Hon. Michael Wynne <i>Under Secretary of Defense for Acquisition, Technology and Logistics</i>	Perspectives on DDR&E Roles and Responsibilities
Dr. Craig Fields <i>Private Consultant (former DARPA Director)</i> Mr. Larry Lynn <i>Private Consultant (former DARPA Director)</i> Mr. Walt Morrow <i>Director Emeritus, MIT Lincoln Laboratory</i> Mr. Vince Vitto <i>President and CEO, The Charles Stark Draper Laboratory, Inc.</i>	Panel Discussion: Challenges Facing the DDR&E

JUNE 8, 2005

Hon. Ken Krieg <i>Under Secretary of Defense, Acquisition, Technology and Logistics</i>	Discussion on the DDR&E
Dr. Tom Connelly <i>Senior Vice President and Chief Science and Technology Officer, DuPont</i>	Roles and Responsibilities of the Chief Technology Officer at DuPont

APPENDIX C

Hon. John Hamre <i>Private Consultant</i> <i>(former Deputy Secretary of Defense)</i>	Perspectives on DDR&E Roles and Responsibilities
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APPENDIX D. A BRIEF HISTORY OF THE OFFICE OF THE DIRECTOR OF DEFENSE RESEARCH AND ENGINEERING¹⁰

Technological superiority has been, and continues to be, a cornerstone of our national military strategy. It has been a key element of deterrence during times of peace. It has provided invaluable options to our national leaders and allies during times of crisis. It has often proved to be a decisive element in times of war. The military capabilities the U.S. possesses today are a legacy of the leadership of high-level technologists within the government, world-class technical staff in DOD, and substantial investment in science and technology guided by long-term visions.

During World War II, the Office of Scientific Research and Development (OSRD) headed by Vannevar Bush demonstrated that American scientists and engineers could contribute significantly to the war efforts. The OSRD projects gave the United States and Allied troops more powerful and more accurate bombs, more effective radars, more reliable detonators, lighter and more accurate weapons, safer and more effective medical treatments, and more versatile vehicles.

After the war, the National Security Act of 1947 created the National Military Establishment, the Departments of the Air Force and the Army, the Munitions Board, the National Security Council and created the Research and Development Board as the highest level research and development (R&D) organization in the Pentagon. Vannevar Bush served as its first chairman (see table D-1).

10. A broader history of DOD S&T leadership can be found in Richard Van Atta, Michael J. Lippitz, and Robert L. Bovey, *DoD Technology Management in a Global Technology Environment*, Alexandria, VA: Institute for Defense Analyses, IDA Paper P-4017, May 2005. This appendix draws from aspects of that research, as pertains specifically to the DDR&E.

Table D-1. Chronology of Research and Engineering Leadership in DOD, 1947–present

1947–1953	
CHAIRMAN, RESEARCH AND DEVELOPMENT BOARD	
Vannevar Bush	Sept 30, 1947–Oct 14, 1948
Karl T. Compton	Oct 15, 1948–Mar 14, 1950
William Webster	Mar 15, 1950–Jul 31, 1951
Walter G. Whitman	Aug 1, 1951–Jun 29, 1953
1953–1957	
ASSISTANT SECRETARY OF DEFENSE (RESEARCH AND DEVELOPMENT)	
Donald A. Quarles	Sep 1, 1953–Aug 14, 1955
Clifford C. Fumas	Dec 1, 1955–Feb 15, 1957
ASSISTANT SECRETARY OF DEFENSE (APPLICATIONS ENGINEERING)	
Frank D. Newbury	Aug 18, 1953–Mar 17, 1957
1957–1958	
ASSISTANT SECRETARY OF DEFENSE (RESEARCH AND ENGINEERING)	
Frank D. Newbury	Mar 18, 1957–May 17, 1957
Paul D. Foote	Sep 10, 1957–Oct 31, 1958
1958–1977	
DIRECTOR, DEFENSE RESEARCH AND ENGINEERING	
Herbert F. York	Dec 30, 1958–Apr 30, 1961
Harold Brown	May 8, 1961–Sep 30, 1965
John S. Foster, Jr.	Oct 1, 1965–Jun 21, 1973
Malcolm R. Currie	Jun 21, 1973–Jan 20, 1977
William J. Perry	Apr 11, 1977–Oct 21, 1977
1977–1977	
UNDER SECRETARY OF DEFENSE FOR RESEARCH AND ENGINEERING	
William J. Perry	Nov 4, 1977–Jan 20, 1981
Richard B. DeLauer	May 7, 1981–Nov 4, 1984
Donald A. Hicks	Aug 6, 1985–Oct 10, 1986
1986–PRESENT	
DIRECTOR, DEFENSE RESEARCH AND ENGINEERING	
Robert C. Duncan	Dec 17, 1987–Nov 30, 1989
Charles M. Herzfeld	Mar 12, 1990–My 18, 1991
Victor Reis	Dec 3, 1991–May 31, 1993
Anita K. Jones	Jun 1, 1993–May 23, 1997
Hans M. Mark	Jul 1, 1998–May 10, 2001
Ronald M. Segal	Aug 14, 2001–present

However, the board was largely ineffective because it lacked authority and because of the decentralization of responsibilities to a complex system of part-time committees. The board did have a positive influence on R&D by providing a mechanism for the exchange of information and ideas and a channel for ideas to reach those with authority and influence in the administration.

The Defense Reorganization Act of 1953 abolished the Research and Development Board and replaced it with two separate full-time staffs, each headed by an Assistant Secretary of Defense for Research and Development and for Applications Engineering. The establishment of these positions was motivated by concerns that modern technology was not being exploited to its full potential. These new positions in the Office of the Secretary of Defense also reflected the authority of the Secretary of Defense over the operations of the individual military departments. In 1957, both secretariats were merged into a single Assistant Secretary of Defense for Research and Engineering.

The launch of Sputnik on October 4, 1957, triggered new initiatives to harness science and technology for national security objectives. The Defense Reorganization Act of 1958 abolished the position and offices of the Assistant Secretary of Defense for Research and Engineering and created the office of the Director of Defense Research and Engineering. The Assistant Secretary's function had been primarily involved with providing advice and program coordination.

The DDR&E, however, was given direct authority to approve, disapprove, or modify all R&D programs of the Department. Key programs in ballistic missiles and satellites ceased to be separately managed by the military services. The Defense Reorganization Act explicitly stated that the DDR&E was equal in status to the service secretaries and ranked higher than any of the assistant secretaries of defense. In short, DDR&E occupied the number three position in the DOD.

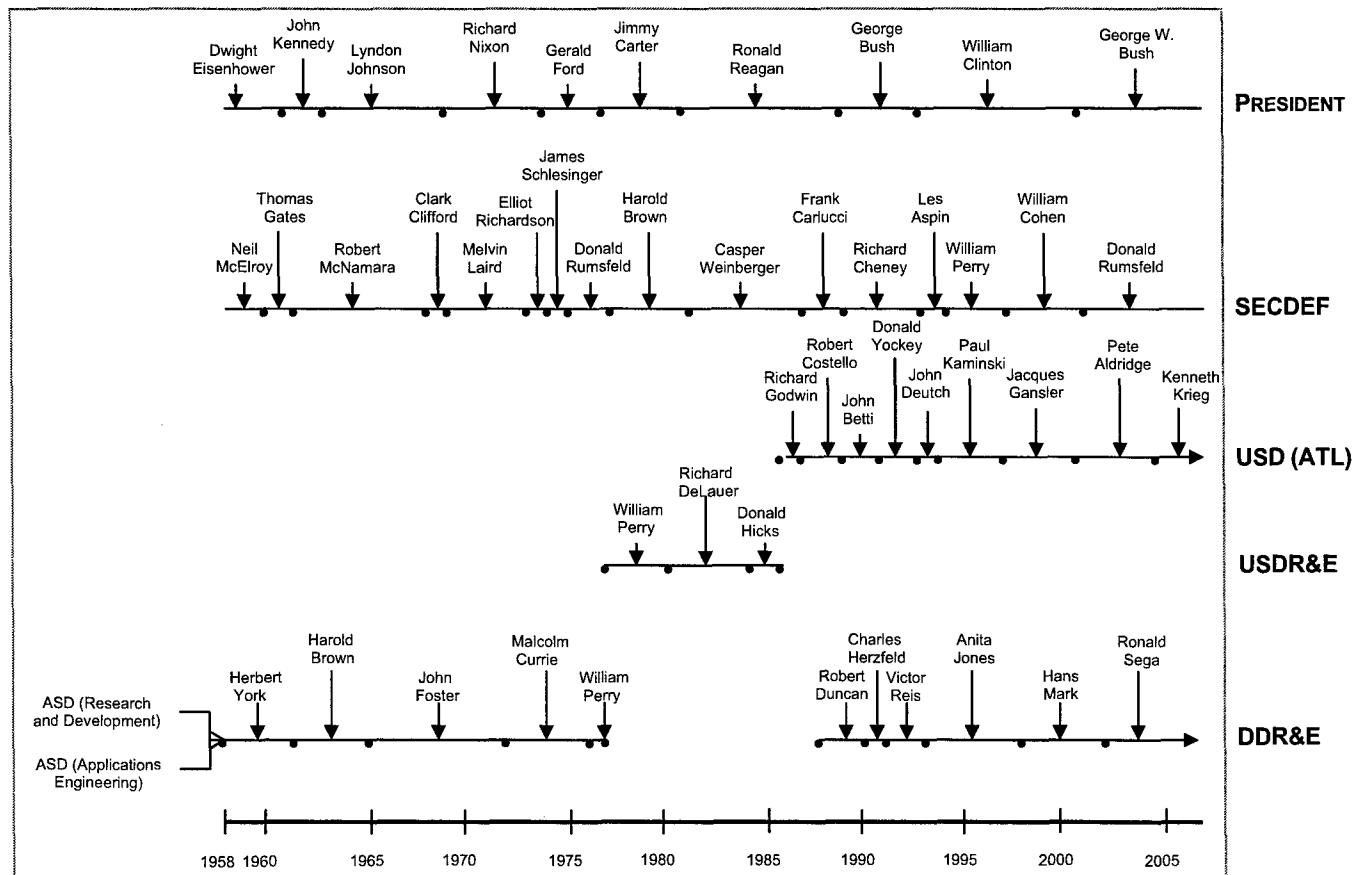
At about the same time, the Advanced Research Projects Agency (ARPA) was formed to execute special projects, separately from the Services, in space and missile defense and other programs not normally supported by the Services. It was also charged with the mission of preventing future technological surprise. While the Director of ARPA initially reported to the Secretary of Defense, within a few years the ARPA Director reported to the DDR&E.

Herbert York was the first DDR&E (see figure D-1). Prior to his appointment, he had been the Director of the Atomic Energy Commission's Lawrence Livermore Laboratory and then the Chief Scientist of the Advanced Research Projects Agency. During his tenure, York recruited a staff of top talent from the aerospace and electronics industries and structured them to focus on problem areas rather than technologies. He also played a role in establishing a centralized organization to develop a national R&D strategy and aggressively guide the execution of that strategy by the military departments and ARPA.

The next two DDR&Es, Harold Brown and John Foster, also came from the Directorship of the Lawrence Livermore Laboratory. Each continued York's efforts to build an office with the best and brightest engineers and scientists. Each also played major roles in shaping U.S. plans and programs in strategic forces, missile defense, and satellite communication and warning. John Foster, in addition, led the development and application of a variety of technologies to support the Vietnam conflict including night vision, laser-guided bombs, satellite communications, ceramic armor, and tactical sensors.

During these years, science and engineering considerations strongly informed national security strategy, plans, and programs. The DDR&E met with the Secretary of Defense on a daily basis and roughly monthly with the President. They had close working relationships with the President's science advisor and other leaders in the administration and Congress. As a result, key leaders were informed about the nation's priorities and science and technology objectives. This gave DDR&E more influence than is normally attributed to a staff position.

Figure D-1. Evolution of the Position of Director, Defense Research and Engineering



In 1973, Malcolm Currie became the first DDR&E from industry. He focused on the Services as the science and technology “customer.” He worked with DARPA and the Services to address Secretary Schlesinger’s guidance to harness emerging technology capabilities to address the challenge of Soviet military buildup to the North Atlantic Treaty Organization forces, particularly in the tactical area. Working with DARPA and the Air Force, Currie entertained and supported research and development to determine the feasibility of stealth technology.

William Perry became DDR&E in early 1977, and like his predecessor, came from the defense industry. Later in 1977, as the result of Secretary of Defense Harold Brown’s concern about the ability to transition research and development results into operational systems, the position of Under Secretary of Defense for Research and Engineering (USD [R&E]) was established and given greater responsibility for system acquisition. At the same time, the position of Under Secretary of Defense for Policy was created and the position of DDR&E was disestablished.

Secretary of Defense Harold Brown and William Perry developed the “offset strategy” – applying U.S. technology to offset the numerical superiority of the Soviet Union. Perry was directly involved with the aggressive development of a new generation of systems emphasizing precision weapons; stealth; and tactical intelligence, surveillance, and reconnaissance. Also, as did all previous DDR&Es, he played an influential role in starting and sustaining programs intended to maintain the U.S. nuclear deterrent.

Richard DeLauer assumed the USD (R&E) position in May 1981. U.S. supremacy now faced more serious technological and economic challenges. DeLauer and Secretary Weinberger set a strategy to strengthen U.S. worldwide technical leadership with an emphasis on increasing basic research and addressing issues with the U.S. military-industrial base. The Strategic Defense Initiative was created and provided a major focus for the application of U.S. technology.

At this time, there was a growing concern about the operational suitability (reliability) of deployed weapon systems. As a result, the

Director of Operational Test and Evaluation, separate from USD (R&E) and reporting directly to the Secretary of Defense, was established in 1984. Continued heightened concern over the management of acquisition continued to dominate USD (R&E) activities through Donald Hick's tenure.

In 1986, the Department of Defense Reorganization Act created the position of Under Secretary of Defense for Acquisition (USD [A]). The position of USD (R&E) was abolished. In 1993, a Department of Defense Directive changed the title of USD (A) to Under Secretary of Defense for Acquisition and Technology and later to Under Secretary of Defense for Acquisition, Technology, and Logistics. USD (A) is the only high-level position (president appointed and Senate approved) required by title 10 of the United States Code to "be appointed from among persons who have an extensive management background in the private sector."

The Defense Reorganization Act failed to mention the position of DDR&E, but this position, reporting to the USD (A), was subsequently re-established by the Military Retirement Reform Act of 1986. The creation of USD (A) had the underlying result of changing the Under Secretary's role from one of being the primary advocate for research and development with acquisition responsibilities to that of being the primary advocate of acquisition reform with research and development responsibilities.

Between 1977 and 1986, the Deputy Under Secretary of Defense for Research and Advanced Technology (DUSD[R&AT]) reported to USD (R&E) and provided review and oversight of all basic research, applied research, and advanced development programs in the Department. DUSD (R&AT) also exercised authority, direction, and control over several R&D organizations. This position was essentially replaced with the title DDR&E in 1986. As late as the year 2000, the OSD organization chart showed the Assistant to the Secretary of Defense for Nuclear and Chemical and Biological Defense (ATSD [NCB]), the Defense Threat Reduction Agency (DTRA), and DARPA reporting to DDR&E. ATSD (NCB) and DTRA no longer report to DDR&E.

The National Defense Authorization Act for fiscal year 1989 directed DOD to prepare and submit a Critical Technologies Plan identifying the top 20 technologies of importance to the DOD. The subsequent report (identifying 22 critical technologies) was criticized for not being a plan or a strategy, but merely a description of current S&T programs. Congressional criticism caused the DDR&E and the Services to create a series of processes to improve S&T planning and review, some of them still in effect today. In 1990, the Services took their own initiative to create an ad hoc organization called the Joint Director of Laboratories (JDL). Shortly thereafter the JDL initiated the Service led "Project Reliance" to consolidate and coordinate, amongst themselves, all S&T programs. Project Reliance ostensibly took on the responsibility of assuring that no duplication of effort existed – a primary responsibility of the DDR&E.

A new S&T strategy was introduced by DDR&E Victor Reis in 1992, with 7 S&T thrusts and 11 key technologies. To review the implementation of the S&T thrusts, DDR&E made heavy use of the 17 Project Reliance technology panels established by the JDL. The 7 S&T thrusts evolved into the creation of the Advanced Concept Development Program and the 11 key technologies expanded to 23 technologies and evolved into the DDR&E Technology Area Plan (DTAP). There, however, remained criticism that these plans were still a list of current programs and not a strategy. Further, the plans were constructed by technologists without the inputs from the military users and, since they were constructed by the JDL Project Reliance Panels, they did not have participation by OSD organizations like DARPA, the Defense Nuclear Agency, and Strategic Defense Initiative.

The Technology Area Review and Assessment (TARA) process was created to elaborate on specific areas of technology, solicit inputs from a wider variety of technologists and users, and to provide a comprehensive defense S&T strategy composed of a coalition of inputs from national and Joint Chief of Staff sources, and Service and agency plans. Inputs from these sources were integrated into three plans: the Basic Research Plan, the Defense Technology Area Plan, and the Joint Warfighting Science and Technology Plan. Much of this process is still in effect today.

From 1958 to 1986, the DDR&E was primarily involved with overcoming the problem of Service-centric stovepipe technology development and balancing the Department's technology portfolio among the Service programs while assuring new competitive capabilities were added to the portfolio. The DDR&E was the strongest advocate for transition of technology into operational capability. Most of the major decisions in the early years were made by a handful of key people. The DDR&E had direct access to the Service Secretaries, the Secretary of Defense, and the President and possessed unquestionable authority to implement decisions.

Over time, the management of science and technology has grown much more complex. There have been significant changes in the world that affect national security and defense S&T strategies—most notably the replacement of the Cold War Soviet threat by new threats to U.S. national security and the globalization of technology. This complexity has been addressed by creating processes that coordinate inputs from claimants and users to form an overall S&T strategy and depends heavily upon the Services to coordinate the execution of that strategy. These changes have caused a fundamental shift in the role of OSD with respect to the Services. The role of DDR&E has likewise shifted from that of "directing" to that of coordinating, facilitating, and arbitrating among elements of a very large S&T infrastructure to assure U.S. military technological leadership is maintained.

It is no longer possible for a small group of brilliant people to direct and control the development of defense science and technology. Yet while the roles and authorities of the DDR&E have changed over time, the importance of science and technology to our national security has not. The need for strong leadership to shape and guide the development of defense science and technology has never been greater.

APPENDIX E. CURRENT ROLES AND RESPONSIBILITIES OF THE DIRECTOR OF DEFENSE RESEARCH AND ENGINEERING¹¹

The DDR&E is the Chief Technology Officer for the Department of Defense. As defined in DOD Directive 5134.3, the DDR&E serves as the principal staff assistant and advisor to the Under Secretary of Defense for Acquisition, Technology and Logistics and the Secretary and Deputy Secretary of Defense for research and engineering matters (see appendix H). The mission of the DDR&E is to ensure that war fighters, both today and tomorrow, have superior and affordable technology to support their missions and to give them revolutionary war-winning capabilities. This mission involves the DDR&E in activities that span technology planning, development, and integration—all with focus on improving the capability of the war fighter.

The roles and responsibilities of the DDR&E involve both strategic planning and oversight functions. Among the DDR&E's oversight functions include programmatic and budget direction, establishing balance between Service and OSD equities, laboratory oversight, and technology transition. Five priority areas for the DDR&E, established in fiscal year 2005, are reviewed below, following an overview of the research and engineering portfolio.

RESEARCH AND ENGINEERING PORTFOLIO

The research and engineering portfolio includes science and technology programs—which consist of basic and applied research and advanced technology development—and advanced component development and prototypes programs, collectively covering budget

11. This appendix provides a description of the research and engineering portfolio and priorities of the DDR&E, under the direction of Dr. Ronald Sega, at the time of the Task Force deliberations. It was provided to the Task Force by Ms. Beth Foster, the Task Force's executive secretary.

activities 1 through 4. The research, development, test, and engineering (RDT&E) budget request for fiscal year 2006 is \$69.36 billion (budget activities 1 through 7). Of this total, the science and technology budget is \$10.5 billion (see table E-1)—comprising 15 percent of the total RDT&E budget. Advanced component development and prototypes add an additional \$14.14 billion within DOD.

Over the last five years, the Department's S&T portfolio has increased significantly from fiscal year 2001. The fiscal year 2006 President's Budget Request is 28 percent higher than the fiscal year 2001 request of \$7.5 billion (see table E-1). However, in fiscal year 2006, the President's Budget Request is expected to drop slightly from the fiscal year 2005 level. This reality reflects the challenges of sustaining a robust investment in S&T, including investments in basic research, during an era where force transformation has dominated defense planning and more recently where war time requirements vie for defense resources.

Table E-1. S&T Budget, Selected Fiscal Years

PRESIDENT BUDGET REQUEST (MILLIONS OF DOLLARS)	FISCAL YEAR		
	2001	2005	2006
Army	\$1,294	\$1,783	\$1,735
Navy/Marine Corps	1,463	1,718	1,776
Air Force	1,291	1,919	1,980
Defense-Wide	3,494	5,130	5,031
Total DOD S&T	\$7,543	\$10,550	\$10,522

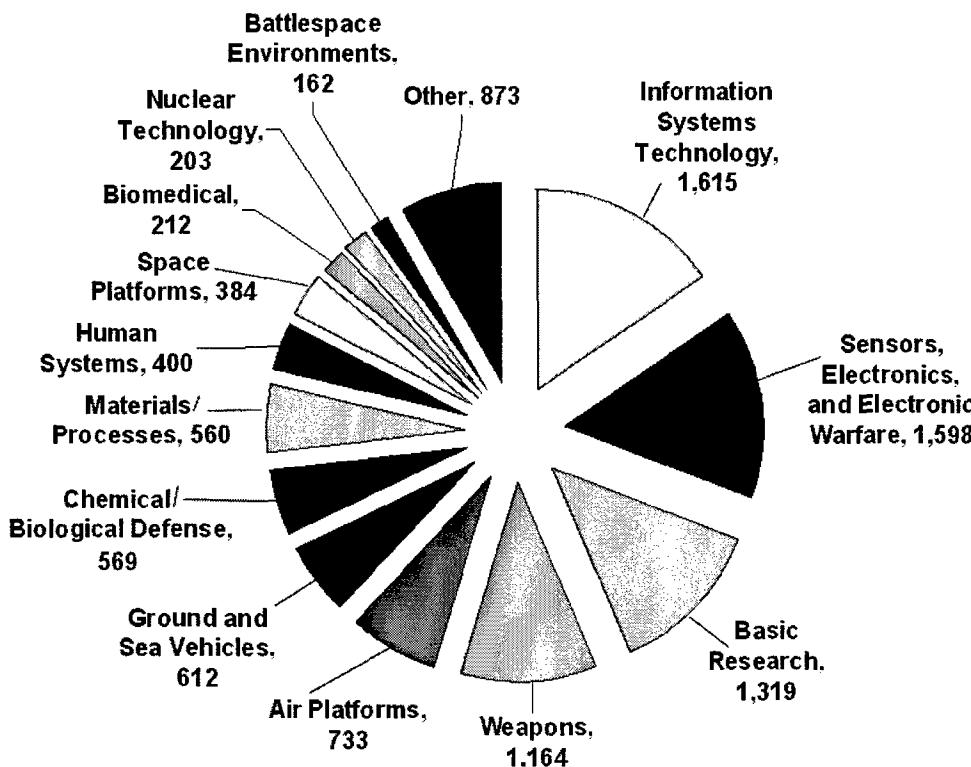
Source: Office of the Director of Defense Research and Engineering

Figure E-1 arrays the S&T program into functional areas. Over 50 percent of the total investment focuses on four functional areas: information systems, sensors and electronics, basic research, and weapons. In short, the program is dominated by investments in “sensing and shooting.”

The fiscal year 2006 budget request reflects some change in S&T priorities and increases investments in chemical and biological

defense, sensors and electronics, hypersonic technologies, network-centric technologies, and high-energy lasers.

Figure E-1. Characterization of the Fiscal Year 2006 DOD S&T Program



Source: Office of the Director of Defense Research and Engineering

When evaluating DOD's S&T budget, it is important to look not only at DOD's own investment but to look at this investment in comparison to others. Thus, the DDR&E is currently engaged in specific technology assessments in areas such as nanotechnology, directed energy, and cruise missile defense.

DDR&E PRIORITIES

In fiscal year 2005, the DDR&E established five priority areas that support the National Security Strategy and Secretary of Defense goals. The five priorities are:

- Integrate DOD science and technology and focus on “transformation”
- Enhance technology transition
- Address national security science and engineering workforce
- Expand outreach to combatant commands and intelligence community
- Accelerate support to the global war on terrorism

Focus S&T on Transformation

Beginning in 2002, the DDR&E took steps to realign S&T funding to focus on transformation. Fundamental to this realignment is to: 1) provide stable funding in basic research to maintain the technology base and sustain the science and engineering workforce and 2) shift S&T investments from traditional to transformational and disruptive technologies. Transformational initiatives underway include the National Aerospace Initiative, with emphasis on high-speed hypersonics, space access, and space technology; energy and power technologies, including power generation, energy storage, and power management and control; and surveillance and knowledge systems.

The following areas are key elements of the focus on transformation:

Disruptive technologies. In 2004, DDR&E sponsored an assessment of disruptive technologies. This study looked at disruptive technologies from several perspectives – what the DOD could bring forward as potential game changes, what other governments and militaries can do to develop new technologies or technologies that might mitigate U.S. capabilities, and unintended uses of technologies

(such as to bring down financial networks or create biological weapons).

Comprehensive review of S&T portfolio. This year, the DDR&E implemented the Comprehensive S&T Review that includes the Technology Area Review and Assessments (TARA) coupled with Investment Strategy Review and Assessment. The purpose of the Comprehensive S&T Review is to strengthen S&T planning by improving the integration of S&T investments with DOD priorities and objectives—to better assess whether the Department is investing in the right programs. In the first year of this two-year review process, DDR&E will examine the Department's investment strategy with an eye toward identifying gaps in DOD investments. The second year, the focus will be on evaluating how well the programs are being executed.

The first investment strategy review, which took place in the winter of 2005, identified the following areas where the Department is under-investing—chemical, biological, radiological, nuclear, and high explosive; cruise missile defense; nonlethal weapons technology; tagging, tracking, and locating of people and things; and novel ways to access space.

Enhance Technology Transition

The war in Iraq has focused significant attention on rapid insertion of technology in the field. The DDR&E is setting up processes to encourage technology transition between military and commercial sectors by matching war fighter needs with S&T and working with the acquisition community to field successful results.

The essence of this challenge is to provide an “on ramp” for industry innovation as well as “off ramps” from S&T to industry and programs, thus providing innovative solutions for the war fighter. Processes such as the Technology Readiness Assessments—part of DAB milestone reviews—help to identify risk areas and serve as a mechanism to improve integration of efforts between the S&T and acquisition communities. The DDR&E is also initiating a Joint Capability Technology Demonstration business process to create a

better model of addressing the different and unique joint and coalition needs. The goal for this process is to engage combatant commands to identify solutions for emerging and validated needs and to speed transformational solutions to the war fighter.

Science and Engineering Workforce

Technical talent is critical – in the labs, in the acquisition workforce, in logistics, on the battlefield. Studies show expected shortfalls in many disciplines important to national security and energy. The DDR&E has proposed legislation to expand the SMART Pilot Program and build a permanent program titled “SMART - National Defense Education Act (NDEA), Phase 1” (also referred to as the National Defense Education Program). The new program would provide additional authorities that could improve substantially the Department’s ability to develop, recruit, and retain individuals who will be critical in fulfilling the national security mission.

Expand Outreach

DDR&E is engaged in initiatives to expand outreach to the combatant commands, the intelligence community, and others. In fiscal year 2005, DDR&E implemented a new process for developing the Joint Warfighting S&T Plan that better defines near- and far-term capability needs in eight joint functional areas. DDR&E and the Under Secretary of Defense for Intelligence are sponsoring technology net assessments to help identify technology capability gaps between the United States and the rest of the world as well as assessments of foreign technology capabilities in high-interest technology areas. DDR&E has also introduced the R&E Portal in an effort to provide current R&E information to the DOD R&E community – including civil service, military, and contractors.

Accelerate Support to the War on Terrorism

The DOD Combating Terrorism Technology Task Force (CTTTF) was established in September 2001 to bring DOD S&T leadership, laboratories, and agencies together to focus on global-war-on-

terrorism challenges. The goal has been to facilitate the rapid transition of mature S&T programs to meet war fighter needs and to increase outreach and information sharing with various government agencies, such as the Department of Justice and the Federal Bureau of Investigation.

RESEARCH AND ENGINEERING GOALS

In February 2005, the DDR&E established seven process goals and eight technical capability goals for the Department of Defense. The technical capability goals were identified to fill current capability gaps and create new advanced capabilities for the future. They cover four areas: protection, situation awareness, strike, and force sustainment. In addition, two cross-cutting capabilities are identified: reusable vehicles for space launch and training tools for complex urban terrain and conventional scenarios.

Underlying these technical capabilities goals are several enabling technology goals—areas that may not lead directly to systems, but are vital for enhancement of military capability. These technology goals are as follows:

- Nanotechnology
- Biotechnology
- Unmanned and autonomous systems
- Quantum communications/computing technology
- Networked systems
- Advanced materials
- Intellectual capital (workforce)
- DOD R&E infrastructure
- Modeling, simulation, computation, and software for complex systems

The goals provide guidance needed to advance near-term capability while maintaining a steady flow of technology options for a future force.

APPENDIX F. REFLECTIONS FROM A FORMER DIRECTOR OF DEFENSE RESEARCH AND ENGINEERING

Looking back on my term as the DDR&E (1965-1973), it seems to me that six priorities received most of my attention: foreign intelligence, deterring the Soviet Union, the Viet Nam conflict, technological possibilities, the science and technology base and education, and the quality and role of the DDR&E staff. I discuss each of these in turn.

Foreign intelligence. The need to focus on intelligence derives from the recognition that if there is no potential adversary to threaten our national security, there is no need for large standing forces. But there were two main adversaries at that time, the Soviet Union and North Vietnam. So, it was critical to understand their capabilities, development efforts, supporting investment trends, and other relevant concerns.

Deterring the Soviet Union. Of particular concern was the Soviet development and deployment of strategic systems – intercontinental ballistic missiles, sea-launched ballistic missiles, and active and passive defenses – as well as a wide range of capabilities arrayed against Western Europe. We had to ensure that U.S. developments and deployments were appropriate to deter Soviet attacks against the United States and its allies.

The Viet Nam conflict. The existence of conflict, in this case Viet Nam, brought tactical surprises and operational shortfalls in our capabilities. This conflict was a matter of priority to the President and the Secretary of Defense and so it was a priority for DDR&E. Because of this sense of urgency, it was necessary to initiate aggressive research, development, engineering, and deployment activities. It was possible to fund such activities because of the priority being given to that conflict. And yes, it was recognized that some of the R&D might not mature before the conflict was over but, if successful, the product would be available for a future conflict.

Technological possibilities. In those days it was clear that we were in the middle of a raging technological revolution—one that has only increased since that time. In such an environment, it was important to identify those possibilities which could “change the game,” and to avoid being surprised by providing unique capabilities or permitting the provision of capabilities at less cost. While the latter is obviously desirable, it usually doesn’t happen unless some authority formally imposes a price limit on the product (an example of which is the F-16).

Identifying possible “game changers” was achieved by calling on senior scientists and engineers of national stature and acting on their recommendations. Having as a ground rule that they would report to the Secretary of Defense made it easier to act on those recommendations.

S&T base and education. Because the DOD is dependent on the national S&T base, it is important to monitor and correct adverse trends. DOD is dependent on universities for the education of its civilians and military, for much of its basic research, and for advice provided by leading academics. For example, it was necessary to establish chairs in certain fields to support our needs (such as systems engineering).

Quality of the DDR&E staff. My predecessor, Harold Brown, told me that the DDR&E staff was the best in the building, and that I must make the effort to assure it remained so. Two things were helpful in that regard. The first was to explain our needs to fill specific positions to the leadership in industry and the university departments. Second, was to arrange to be directed to make staff reductions beyond what was being requested by the Department in order to make room for the best people we could find. It was a matter of quality, not quantity. It was important to focus our effort on identifying the important problems and opportunities and the approaches to address them. That was our job. It was equally difficult to leave it to the Services and agencies to propose and implement the programs, which we would then oversee.

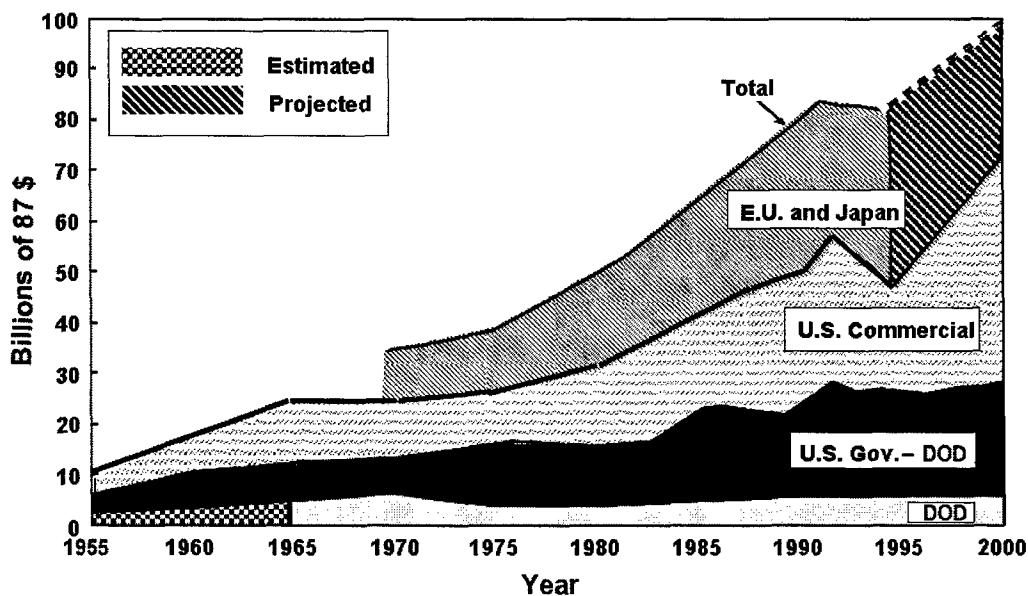
Of course, all of that was then and this is now. The organizational situation is different as are the authorities. We have a new set of potential adversaries and we are at war. Yet it seems to me that the priorities and approaches of four decades ago are still appropriate today. Today's DDR&E can still seize upon a few key problems and opportunities, work out strategies to address them, and go to the Secretary for his support and signature on a directive providing DDR&E with all the authority necessary to proceed. Of course, it is necessary to attract a DDR&E with the appropriate experience and leadership. Then it's just a matter of seizing the burden of initiative.

— Dr. John S. Foster, Jr.

APPENDIX G. U.S. AND WORLDWIDE RESEARCH BASE SINCE WORLD WAR II

One legacy of the effort to modernize America's Armed Forces during World War II was a large defense-focused technology and industrial base, consisting of government, academic-related, and industrial organizations. During the Cold War, this base continued to support the Department of Defense, with commercial and academic establishments taking on an increasing share of research. Since the end of the Cold War, these trends have accelerated, while overseas research has increased as well (figure G-1).

Table G-1. U.S. and Worldwide Research Base since World War II



Source: Report of the Defense Science Board Task Force on the Technology Capabilities of Non-DoD Providers; June 2000; Data provided by the Organization for Economic Cooperation and Development & National Science Foundation

Today, DOD no longer dominates the science and technology research base as it did after World War II. The vast majority of S&T is performed by the civil sector. Relative to DOD's near-stable contributions since the late 1950s, the U.S. civilian and worldwide research base has increased significantly. What this means is that the U.S. government and its laboratories and contractors no longer own or control most of the defense-relevant technology. Further, it means that potential adversaries have as much access to commercially-developed technology as does the United States.

Knowledge of this changing research base, of emerging science and technology capabilities, and their impact on military capabilities is critical to developing DOD strategies, plans, and programs.

**APPENDIX H. DEPARTMENT OF DEFENSE DIRECTIVE
5134.3: DIRECTOR OF DEFENSE RESEARCH AND
ENGINEERING**



Department of Defense DIRECTIVE

NUMBER 5134.3

November 3, 2003

DA&M

SUBJECT: Director of Defense Research and Engineering (DDR&E)

References:

- (a) Sections 137 and 113 of title 10, United States Code
- (b) DoD Directive 5134.3, "Director of Defense Research and Engineering (DDR&E)," August 31, 1994 (hereby canceled)
- (c) DoD 7000.14-R, "DoD Financial Management Regulation," Volume 2, "Budget Formulation and Presentation," July 1996
- (d) DoD Instruction 5000.2, "Operation of the Defense Acquisition System," May 12, 2003
- (e) through (g), see enclosure 1

1. REISSUANCE AND PURPOSE

Pursuant to section 137 of reference (a) and the authorities vested in the Secretary of Defense by section 113 of reference (a), this Directive reissues reference (b) to update the responsibilities, functions, relationships, and authorities of the Director of Defense Research and Engineering (DDR&E).

2. APPLICABILITY

This Directive applies to the Office of the Secretary of Defense, the Military Departments, the Chairman of the Joint Chiefs of Staff, the Combatant Commands, the Office of the Inspector General of the Department of Defense, the Defense Agencies, the DoD Field Activities, and all other organizational entities in the Department of Defense (hereafter referred to collectively as "the DoD Components").

3. DEFINITION

Research and Engineering. Research and Engineering (R&E) includes Science and Technology programs (consisting of Basic Research, Applied Research, and Advanced Technology Development) and Advanced Component Development and Prototypes programs, which are identified as Budget Activities 1, 2, 3, and 4, respectively, in reference (c).

4. RESPONSIBILITIES AND FUNCTIONS

The DDR&E is the principal staff advisor to the Under Secretary of Defense for Acquisition, Technology, and Logistics (USD(AT&L)) and the Secretary and Deputy Secretary of Defense for research and engineering matters. In this capacity, the DDR&E shall:

4.1. Serve as the Chief Technology Officer for the Department of Defense.

4.2. Develop the strategies and supporting plans that exploit technology and prototypes to respond to the needs of the Department of Defense and ensure U.S. technological superiority.

4.3. Conduct analyses and studies; develop policies; provide technical leadership, oversight and advice; make recommendations; and issue guidance for the DoD R&E plans and programs.

4.4. Recommend approval, modification, or disapproval of programs and projects of the Military Departments and other DoD Components in assigned fields to eliminate unpromising or unnecessarily duplicative programs, and initiation or support of promising ones for R&E.

4.5. Actively participate in the Planning, Programming, Budgeting, and Execution process by providing guidance throughout budget development, and:

4.5.1. Oversee a process, that includes the DoD Components, as appropriate, to identify critical technology areas. Provide input into the Defense Planning Guidance and Transformation Planning Guidance concerning these critical technology areas and overall content of the R&E Program, consistent with a capabilities-based planning approach.

4.5.2. In coordination with the DoD Components, develop the Technology Planning Guidance for the Secretary of Defense's approval early in the budget

preparation cycle. The Technology Planning Guidance shall outline programmatic investment priorities consistent with DoD policy and DoD Component transformational objectives.

4.5.3. Recommend, through the USD(AT&L) to the Secretary of Defense, appropriate funding levels for R&E.

4.5.4. Represent the R&E Program as a member of the Program Review Group or equal management structure during the Program Review.

4.5.5. Recommend, through the USD(AT&L) to the Under Secretary of Defense (Comptroller) (USD(C))/Chief Financial Officer (CFO), resource and programmatic adjustments to the Budget Estimate Submission for the Presidents Budget Request on specific R&E programs and technology areas to meet military goals and objectives, as determined by the Chairman of the Joint Chiefs of Staff and the Secretaries of the Military Departments.

4.5.6. Advise the Secretary of Defense whether the Presidents Budget Request meets the Department's goals and objectives and is the best allocation of resources for R&E. If not, identify reallocations required to achieve the desired results.

4.6. Oversee matters associated with R&E at DoD laboratories operated by the Military Departments or other DoD Components.

4.7. Promote coordination, cooperation, and mutual understanding of R&E within the Department of Defense and between the Department of Defense and other Federal Agencies and the civilian community.

4.8. Ensure R&E interchange with Allied and friendly nations, in coordination with the Under Secretary of Defense for Policy, the USD(AT&L), and the Military Departments.

4.9. Provide support to the Defense Technology Security Administration on technological issues pertaining to international acquisition and export activities.

4.10. In cooperation with the Deputy Under Secretary of Defense for Acquisition and Technology, provide advice and assistance in developing policies for rapid technology transition.

4.11. Develop and maintain an R&E metrics program to measure and assess the quality and progress for the Department of Defense's R&E program.

4.12. Provide specific technical evaluation of DoD Component R&E Special Access Programs, as directed by the USD(AT&L) and in coordination with the OUSD(AT&L) Director, Special Programs.

4.13. Provide technical support to the USD(AT&L) on:

4.13.1. R&E aspects of programs subject to review by the Defense Acquisition Board, to include conduct of a complete assessment of technology readiness consistent with DoD Instruction 5000.2 (reference (d)); and

4.13.2. R&E matters pertaining to maintenance of a strong defense industrial base.

4.14. Serve on boards, committees, and other groups pertaining to the DDR&E's functional areas, and represent the Secretary of Defense, the Deputy Secretary of Defense, and the USD(AT&L) on DDR&E matters outside the Department of Defense.

4.15. Carry out such other functions and responsibilities as the Secretary and Deputy Secretary of Defense, or the USD(AT&L), may direct.

5. RELATIONSHIPS

5.1. In the performance of assigned functions and responsibilities, the DDR&E shall:

5.1.1. Serve under the authority, direction, and control of the USD(AT&L) in accordance with DoD Directive 5134.1 (reference (e)).

5.1.2. Exercise authority, direction, and control over the Director of the Defense Advanced Research Projects Agency.

5.1.3. Use existing facilities and services of the Department of Defense and other Federal Agencies, whenever practicable, to avoid duplication and to achieve an appropriate balance among modernization, readiness, sustainability, efficiency, and economy.

5.1.4. Coordinate and exchange information with other OSD officials, the Heads of the DoD Components, and Federal officials having collateral or related functions.

5.2. The USD(C)/CFO shall coordinate with the DDR&E prior to approving the transfer or reprogramming of funds into or from a program supported by funds from Budget Activities 1 through 4.

5.3. Other OSD officials and the Heads of the DoD Components shall coordinate with the DDR&E on all matters related to the responsibilities and functions cited in section 4., above.

6. AUTHORITIES

The DDR&E is hereby delegated authority to:

6.1. Issue DoD Instructions, DoD Publications, and one-time directive-type memoranda, consistent with DoD 5025.1-M (reference (f)), that implement policy approved by the Secretary of Defense in assigned fields of responsibility. Instructions to the Military Departments shall be issued through the Secretaries of the Military Departments. Instructions to the Combatant Commands shall be communicated through the Chairman of the Joint Chiefs of Staff.

6.2. Obtain reports and information, consistent with the policies and criteria of DoD Directive 8910.1 (reference (g)), as necessary, to carry out assigned functions.

6.3. Communicate directly with the Heads of the DoD Components, as necessary to carry out assigned functions, including the transmission of requests for advice and assistance. Communications to the Military Departments shall be transmitted through the Secretaries of the Military Departments, their designees, or as otherwise provided in law or directed by the Secretary of Defense in other DoD issuances. Communications to the Commanders of the Combatant Commands, except in unusual circumstances, shall be transmitted through the Chairman of the Joint Chiefs of Staff.

6.4. Communicate with other Federal Agencies, representatives of the Legislative Branch, members of the public, and representatives of foreign governments, as appropriate, in carrying out assigned functions.

6.5. Establish arrangements for DoD participation in those non-defense governmental programs for which the DDR&E has been assigned primary cognizance.

7. EFFECTIVE DATE

This Directive is effective immediately.



Paul Wolfowitz
Deputy Secretary of Defense

Enclosures - 1

E1. References, continued

E1. ENCLOSURE 1

REFERENCES, continued

- (e) DoD Directive 5134.1, "Under Secretary of Defense for Acquisition, Technology, and Logistics," April 21, 2000
- (f) DoD 5025.1-M, "DoD Directives System Procedures," March 5, 2003
- (g) DoD Directive 8910.1, "Management and Control of Information Requirements," June 11, 1993

APPENDIX I. THE ROLE OF CHIEF TECHNOLOGY OFFICERS

The roles of the DDR&E as Chief Technology Officer of the Department of Defense is prescribed by Department of Defense Directive 5134.3, dated November 3, 2003. In order to provide a broad context for considering this responsibility, the Task Force looked to industry experience and addressed the following questions: What models exist in industry with regard to a CTO function? What responsibilities, authorities, and reporting relationships do industry CTOs have? How does this compare to DOD? What industry approaches could DOD adopt?

CHIEF TECHNOLOGY OFFICERS IN INDUSTRY

The position of Chief Technology Officer in industry has evolved over the past 20 to 30 years from a period when most companies did not have a CTO to their widespread use today. By the 1990s the position requirements evolved from a highly-published laboratory researcher with great depth in a single field to an operational executive who can make important strategic decisions that impact the competitive position of a company. The modern CTO position often calls for a technologist or scientist who can translate technological capabilities into strategic business decisions. Lewis describes the nature of this role: "The CTO's key tasks are not those of lab director writ large but, rather, of a technical businessperson deeply involved in shaping and implementing overall corporate strategy."¹²

Models

There are few examples in the literature (papers, journal articles, and presentations) of explicitly defined roles, authorities, and responsibilities of a CTO in industry. How this person contributes to an organization varies widely. Looking across a range of industries,

12. Lewis, W.W., & Lawrence, H.L. (1990). A new mission for corporate technology. *Sloan Management Review*, 31(4), pp. 57-67.

the CTO has been used as a technical trouble shooter for the chairman, to leverage technology across internal businesses, to provide insight for new directions in technology, and often as combinations of all of these.

There has been little research done to define the CTO's responsibilities. From the "CTO.net" established by Roger E. Smith,

Each industry has a very different business model (even within the same industry), customer base, internal structure, and culture. The position is poorly understood and unevenly applied: CTOs are not publishing their activities and academics are not researching the position. Fewer than 20 published journal articles in the last 10 years. It is unlikely, if not impossible, for one definition or model to meet the needs of all of these organizations.¹³

Responsibilities

Although there is no single model that can be used for the role of CTOs, Smith has characterized CTO strategic responsibilities in a review paper. Smith's characterization identifies the following responsibilities:

- *Monitoring and assessing new technologies.* ... Serve as an advisor to senior executives during strategic decision-making. ... identify, access, [and] investigate high-risk, high-return technologies possessing potential application within existing businesses or for creating new businesses.
...
- *Strategic innovation.* ... Assure development or acquisition of fundamental technologies offering clear competitive advantage for current and future businesses. ...
- *Mergers and acquisitions.* ... Due diligence includes evaluating patents, reviewing technical publications, and studying trade data to determine the value of the target company and to rank it against its competitors. ...

13. Smith, Roger D. (October 2003). "Strategic Responsibilities of the Chief Technology Officer," *Technology Management Journal*, Korean Industrial Technology Association.

- *Marketing and media relations.* ... Translate technical details into real customer advantages that are superior to those of competing products. ...
- *Government, academia, professional organizations.* ... Ensure that money and time spent on such projects is aligned with corporate strategy and has a realistic potential of contributing to company's competitive advantage. ...
- *Company culture.* ... Initiate activities and policies that create a technology-friendly culture aligned with company's business strategy.¹⁴

From Task Force interviews and discussions, the following are further illustrations of CTO roles in industry:

- Participate in senior leadership team for preparing business plans and directions
- Review business unit engineering support plans (tech roadmaps and independent research and development [IRAD])
- Conduct executive oversight of technology initiatives occurring in the corporate research organization (laboratory vice president or director typically reports to CTO)
- Lead in the establishment of global research facilities
- Assist business units with new initiatives and continually evaluate evolving technologies used in company products
- Provide recommendations to chairman and to senior leadership team on advanced products and technology gaps (IRAD investments)

Authorities

The Task Force examined the authority of the CTO in the area of R&D resources — who controls the resources and how they are

14. Smith, Roger D. (July-August 2003) "The Chief Technology Officer: Strategic Responsibilities and Relationships," *Research Technology Management*, CTOnet.org.

allocated. For large aerospace and commercial sector companies, CTOs are often staff positions with no line authority. If there is a central research laboratory, the lab vice president or director often reports to the CTO. Since business units are responsible for profit and loss, they are also responsible for determining R&D investments needed to grow their business unit. The CTO's authority lies with the chairman and chief executive office (CEO) to provide advice or set technology goals for the senior leaders of the company as to the direction and appropriateness of business unit investments.

Reporting

From the Task Force review of companies in the defense and commercial sectors, the CTO most often reports to and advises the chairman or CEO on potential technology impacts and discontinuities that can help shape future business growth. Business units will seek advice and support on new initiatives or issues and will often depend on the CTO to lead research and engineering "processes" across the corporation.

DOD VERSUS INDUSTRY CTOs—SUMMARY COMPARISONS

Table I-1 summarizes CTO authorities and responsibilities in DOD as compared to industry.

Industry CTOs will most often have the role of setting strategic technology directions for their company and leave the IRAD performance of the business unit to that leadership. The Task Force does believe that the appropriate role for DDR&E as DOD's Chief Technology Officer is to focus on strategic issues rather than to provide oversight of the S&T portfolio. The essence of the CTO's role goes beyond oversight of the Department's research and engineering activities and is captured by item 4.2 in Department of Defense Directive 5134.3 dated November 3, 2003. DOD's CTO role is to "Develop the strategies and supporting plans that exploit technology and prototypes to respond to the needs of the Department of Defense and ensure U.S. technological superiority."

Table I-1. Comparison of DOD and Industry CTO Authorities and Responsibilities

DOD CTO	INDUSTRY CTO
Principal staff advisor to the Under Secretary of Defense for Acquisition, Technology, and Logistics and the Secretary and Deputy Secretary of Defense for research and engineering matters.	Reports to chairman and provides advice on research and engineering matters.
Develop the strategies and supporting plans that exploit technology and prototypes to respond to the needs of the Department of Defense and ensure U.S. technological superiority.	Assures strategic innovation in fundamental technologies offering clear competitive advantage for current & future businesses.
Develop and maintain an R&E metrics program to measure and assess the quality and progress for the Department of Defense's R&E program.	Metrics regarding revenue increase from new products introduced in a desired cycle time are fundamental to business growth.
Recommend approval, modification, or disapproval of programs and projects of the military departments and other DOD Components in assigned fields to eliminate unpromising or unnecessarily duplicative programs, and initiation or support of promising ones for R&E.	Technology gates monitored to decide if a project moves to next stage of development or is killed.
Actively participate in the Planning, Programming, Budgeting, and Execution process by providing guidance through out budget development. Advise the Secretary of Defense whether the Presidents Budget Request meets the Department's goals and objectives and is the best allocation of resources for R&E. If not, identify reallocations required to achieve the desired results.	Serve as an advisor to senior executives during strategic decision-making. Identify, access, [and] investigate high-risk, high-return technologies possessing potential application within existing businesses or for creating new businesses.
Promote coordination, cooperation, and mutual understanding of R&E within the Department of Defense and between the Department of Defense and other federal agencies and the civilian community.	Assist business units on new initiatives and continually evaluate evolving technologies used in company products.

Table I-1. Comparison of DOD and Industry CTO Authorities and Responsibilities (continued)

DOD CTO	INDUSTRY CTO
Ensure R&E interchange with Allied and friendly nations, in coordination with the Under Secretary of Defense for Policy, the USD (AT&L), and the military departments.	Lead in the establishment of global research facilities.
Oversee matters associated with R&E at DOD laboratories operated by the military departments or other DOD components.	Executive oversight of technology initiatives occurring in the corporate research organization (laboratory vice president/ director reports to CTO)
Conduct analyses and studies; develop policies; provide technical leadership, oversight, and advice; make recommendations; and issue guidance to military services and defense agencies for the DOD R&E plans and programs.	Initiate activities and policies that create an innovation and technology-friendly culture aligned with company's business strategy.
Serve on boards, committees, and other groups pertaining to the DDR&E's functional areas, and represent the Department of Defense, the Deputy Secretary of Defense, and the USD (AT&L) on DDR&E matters outside the Department of Defense.	Serve in government, academic, or professional organizations. Insure that money and time spent on such projects is aligned with corporate strategy and has realistic potential of contributing to company's competitive advantage.

For the DDR&E to effectively perform the job of CTO requires guidance, and support, from the Secretary of Defense and the USD (AT&L). DDR&E is a staff position (to the Secretary of Defense), not a line position, and, as such, the influence of the office depends on the relationship and support of the Secretary of Defense. Within industry the CTO typically reports directly to the chairman and chief executive officer. This relationship is critical for setting technical competitiveness and innovation for the company. When business unit leaders recognize that the CTO has the backing of the chairman, their individual plans for growth better reflect the strategic plans of the corporation.

APPENDIX J. DRAFT SECRETARY OF DEFENSE IMPLEMENTATION MEMORANDUM

MEMORANDUM FOR

**SECRETARIES OF THE MILITARY DEPARTMENTS
CHAIRMAN OF THE JOINT CHIEFS OF STAFF
UNDER SECRETARIES OF DEFENSE
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DIRECTOR, PROGRAM ANALYSIS AND EVALUATION
DIRECTOR, NET ASSESSMENT
DIRECTOR, FORCE TRANSFORMATION
DIRECTORS OF THE DEFENSE AGENCIES
DIRECTORS OF THE DOD FIELD ACTIVITIES**

SUBJECT: DOD Strategic Technology Plan

The Department's preeminent ability to understand, nurture and exploit science and technology (S&T) was a major contributor to victory in the Cold War. This ability has remained a critical enabler of the powerful new capabilities we have demonstrated since.

However, our ability to continue to do so faces new challenges, not the least of which is the commercialization and globalization of technology. Resourceful adversaries now have a much richer menu of technologies to exploit for their own use against U.S. interests. At the same time our ability to use all available technology is hampered by research and development practices still influenced by Cold War requirements.

Civilian technologies undergoing revolutionary progress can have profound and unforeseen influence on future military affairs. We have not seen the last of such impacts from information technology. We will surely

see more from biotechnology and nanotechnology. We must ensure that we are the first to understand these effects and the first to exploit or counter them as appropriate.

Furthermore, while critical, technology is only an enabler of new capabilities. The capabilities we need to counter new threats depend perhaps even more so than during the Cold War, on our human resources. Therefore, we must foster closer collaboration between our warriors and technologists so that the introduction of new technology is tied to development of concepts, doctrine, tactics and training.

In the face of these challenges I have asked the USD (AT&L) and the DDR&E, in accord with Department of Defense Directive 5134.3, to take steps to ensure that we will exploit technology to the fullest and avoid technological surprise. One of these steps is to develop a strategic technology plan. The plan is intended to help ensure on the one hand, that our S&T activities support national defense goals, and on the other, that our strategies are informed by a deep understanding of technology. The strategic plan should be developed within 90 days of receiving this memorandum and be updated annually.

The plan will provide a rationale and roadmap for a robust long-term science and technology effort. It will tie technology objectives closer to the operational capabilities spelled out in the National Defense Strategy. It will identify

- Critical investment areas
- How to make much more effective use of technology developed in the commercial sector, academia, and other government agencies
- Ways to be more successful in anticipating how adversaries will exploit technology. This will involve the intelligence community and require red teaming and net assessment
- Means for more timely collaboration between warriors and technologists to permit rapid insertion of new capabilities into ongoing operations.

- Steps to increase the technical depth and breadth of the OUSD (AT&L) staff

The Deputy Secretary and I are committed to spend the time needed to achieve these objectives. Please provide the necessary support to this important effort.